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COMMUNICATIONS

A CASE OF POLYCYTHAEMIA VERA—EXTRACTION OF BOTH LENSES. SATISFACTORY RESULT*

BY

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LONDON

As this case seems nearly unique, I felt justified in publishing it, especially as it may be of use to other surgeons who are dealing with a similar case.

W. W. H., aged 74 years, consulted me in March, 1942, in reference to his eyesight. On examination of his eyes I found as follows.

Right eye, a well marked cataract; under homatropine and cocaine the pupil was well dilated and, though no details of the fundus could be seen, the disc appeared normal: the vision was less than 6/60. *Perception and projection of light were very good.*

Left eye.—Vision with glasses 6/36; under H. and C. pupil dilated well. *Macular region* was clear and no haemorrhages were seen. C. Sph. −5·00 Sph. ○ Cyl. 1·50/17° = 6/18.

On questioning the patient the following history was elicited. In December, 1940, he consulted an ophthalmic surgeon, who made the following report:—

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Right eye.—Early cataract. Left eye.—Very suffused disc, ? hypertensive.

It was suggested he should have thorough examination. His *blood pressure* was 160/90. *Urine* showed no sugar or albumen.

Apparently the sight became worse. In January, 1941, he was examined again and a retinal haemorrhage at the macula was found in the *left* eye. It was suggested he should have a blood count done; the report was:—

Red blood corpuscles 7,250,000. White blood corpuscles 12,000. *Stained Slide* no abnormal white cells seen.

Diagnosis Polycythaemia.

As the sight became worse, the question of the right lens being extracted arose, but the surgeon thought this was unwise, as he felt there might be some lesion in the right fundus which might prevent a good visual result. The patient was sent to a physician in reference to his blood condition, and it was decided that no special treatment was necessary.

I was asked by the patient in March, 1942, whether I felt justified in operating and, as the projection of and perception to light were good and the pupil dilated fully under H. and C. and tension was normal, I said that I felt an operation for removal of the lens could be done—though I could not promise what the visual result would be.

In June, 1942, I extracted the right lens, the operation being extrascapular with a small peripheral iridectomy. Except for a slight attack of gouty conjunctivitis (the patient had an attack of gout on his finger), the convalescence was uneventful, the visual result C. +11·0 Sph. +3·0 Cyl.=6/6. Add +3·5 Sph.=J.1

On examination of the fundus, just below and internal to the macular region, was a patch of old choroiditis, in appearance resembling Tay's choroiditis, but fortunately it was clear away from the macular region.

On February 21, 1943, the vision of the *right* eye was still 6/6 and I was asked, as the sight had greatly deteriorated in the *left* eye, whether I could extract the *left* lens. I said, as there had been active mischief in this eye and a retinal lesion at the macula, I could not be sure what the result would be, but that I would extract the lens if the patient wished it.

The *second operation* was undertaken in June, 1943. The result was perfect and there were *no* complications.

Visión C. + 11·0 D. sph. =6/6; +3·5 D. sph. added =J.1

Having become interested in this condition, I looked up numerous papers and abstracts from foreign journals, especially with reference to operative procedure. I could only find one instance of any operative interference and this was a case of Professor Ballantyne's

who was obliged to do a trephining operation in a case with secondary glaucoma.

As I have been kindly allowed to reproduce the paintings of the fundi in a case of *polycythaemia vera* under the care of Mr. Nutt, of Sheffield, I feel a short description of the condition would not be out of place.

Polycythaemia is a clinical condition caused by a primary hyperplasia of the erythroblastic elements of the bone marrow. Its origin is unknown; on examination of the fundus special lesions are present. These are so characteristic that Ascher used the term fundus polycythemicus.

There are two types of polycythaemia:—

(1) The *primary* form, or polycythaemia vera, is characterised by the increase in number of red blood cells, the haemoglobin content, and the volume of blood, and is accompanied by headaches, malaise, nervous symptoms, general cyanosis and enlargement of the spleen. It generally occurs between the ages of 35 and 65.

(2) The *secondary* or compensatory form is usually due to congenital heart disease, may be due to emphysema or stenosis of pulmonary vessels, and has occurred in cholera and dysentry. It may occur at any age; in the secondary type the cyanosis is more marked. Either type may be associated with mild or severe fundus changes.

Another type of polycythaemia is known as polycythaemia hypertonica or Gaisböck disease. This type is associated with arterio-sclerosis, cardiac disease and renal changes, and is accompanied by high blood pressure without splenomegaly.

The characteristic blood picture of polycythaemia is a high increase in the number of red blood cells—from 7,000,000 to 10,000,000, with an increase in the haemoglobin from 110 to 126 per cent. The colour index is low, but the volume and viscosity of the blood are increased.

The characteristic findings in the fundus in polycythaemia are marked distension, and engorgement of the retinal veins, which appear purplish. The distension is due to the increase of the blood volume and thinning of the venous walls.

In the secondary type, the retinal arteries are also moderately dilated and purplish. Other changes which have been described are retinal thromboses, small scattered haemorrhages, round shaped in appearance.

Hyperaemia of the disc is often seen. Some authors have also described a bluish cupping of the disc, and have stated that in typical cases of polycythaemia without fundus lesions, but with interference of vision, a retrobulbar neuritis may be present. With the slit-lamp the vessels of the iris are sometimes found dilated, with a brown area of dust-like pigment.

External changes in the eyes have been noted in some cases, such as congestion of ocular and tarsal conjunctivae, but these changes are shown generally in the severe congestive types of secondary polycythaemia.

Visual acuity in polycythaemia. In reading through numerous cases one is struck by the good vision these cases have—even after severe changes have been noted; and in the cases where the vision is poor, there are generally added complications, which do not seem due to the actual blood condition, but secondary conditions which have arisen due to the patient's general state of health.

The paintings which the editorial committee of the *Brit. Jl. of Ophthal.* have kindly permitted to be reproduced in colour show the cardinal signs of polycythaemia very plainly, namely, the very engorged, tortuous and swollen retinal veins, the hyperaemic discs and the marked venous haemorrhages.

The paintings are from the fundus of a woman, aged 36 years. The vision was:—Right eye 6/9, Left eye 6/9. *Blood count* (August, 1928), 19 million red corpuscles, haemoglobin 140 per cent.

History. 1921, after the birth of twins, first noticed a high colour on her face. She began to have attacks of dyspepsia and headaches, later vertigo and vomiting. *Spleen*, easily palpable, *colour index*, 0·66.

Treatment. Venesection (repeated) from October 28 to November 21, 1928, with administration of phenyl hydrazine, which reduced the blood count to red cells 5,170,000.

On January 13, 1929, vision with glasses was 6/5, Right and Left. Visual fields were contracted, especially to red and green.

I am greatly indebted to Professor Ballantyne for the help he gave in connection with cases he had, and also for the numerous references to principal papers written on the subject; also to Professor Cohen, of Liverpool, who especially helped me in cases with so-called Gaisböck disease. Apart from the numerous references given, I should like to mention the admirable article on polycythaemia vera in the third volume of Duke-Elder's Text-book of Ophthalmology.

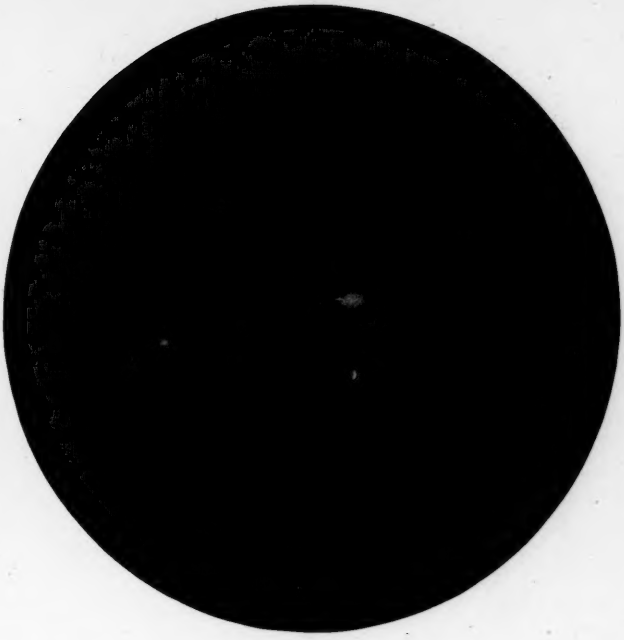
Conclusion

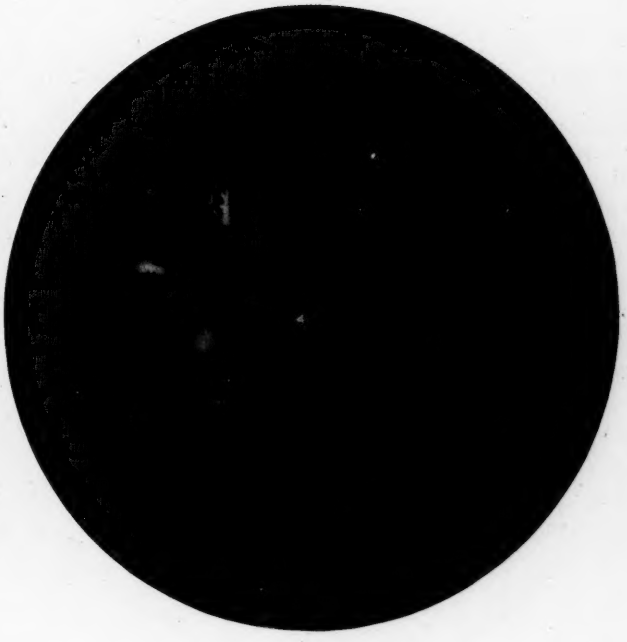
(i) Polycythaemia is much more common than one thinks, but does not come so often into the hands of the ophthalmic surgeon.

(ii) Though the case is often severe, as seen in the case reported, the eye condition does return to normal.

(iii) It is justifiable to carry out operations, if required.

(iv) Care must be taken not to confuse this condition with that of a cerebral tumour, associated with headaches and papilloedema.





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A CASE OF CORNEA PLANA*

BY

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R.A.M.C

FROM a perusal of the literature on the condition known as cornea plana, it is evident that this malformation is one of very considerable rarity—in fact, in English Literature only two descriptive papers have been published, Swett (1924), and Barkan and Borley (1936). The latter authors, in an exhaustive article, review the literature on cornea plana and add three cases occurring in one family—mother and two daughters. They discuss the diagnosis, emphasising the distinguishing features between the condition and microphthalmia, and the possibility of glaucoma as a complication. According to these authors, "cornea plana is that condition in which the radius of curvature of the anterior portion of the eyeball, specifically the cornea, is the same as that of the eyeball."

I believe that the case which I describe and illustrate photographically, is one of this rare malformation, and as such consider it worthy of record.

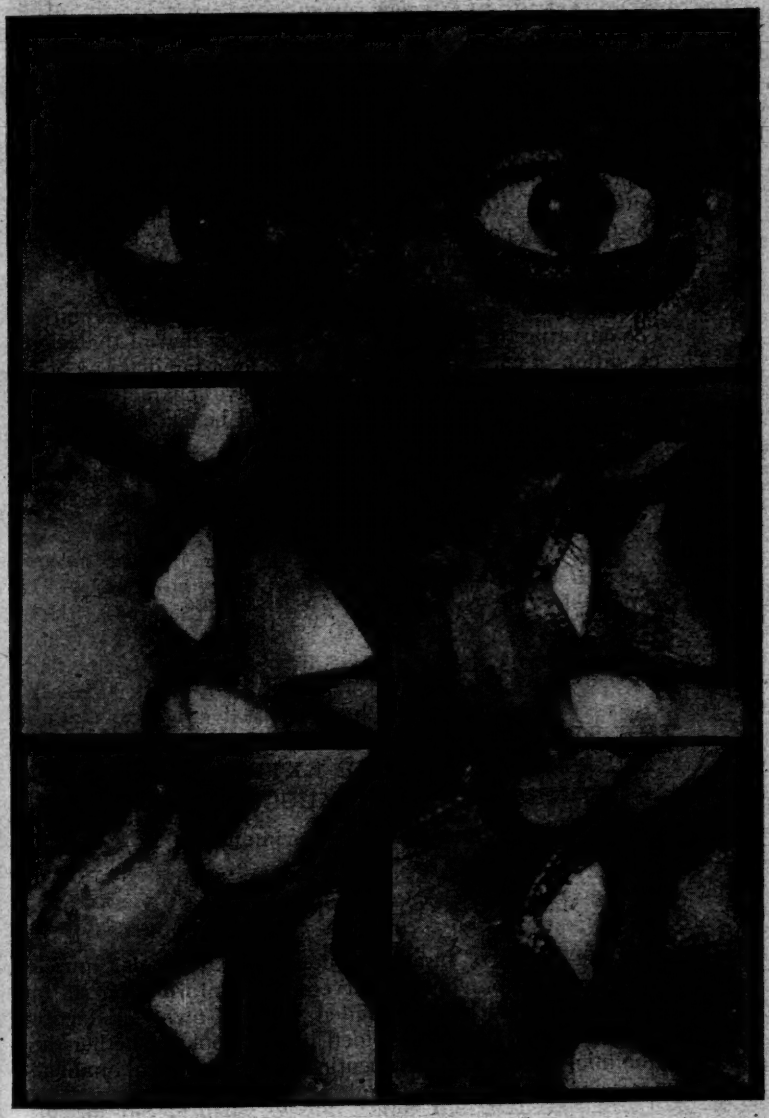
A Greek soldier, aged 28 years, reported to Eye O. P. D. of a General Hospital on Sept. 4, 1942, complaining of defective vision. An accurate history was difficult to obtain, but apparently his visual acuity had always been poor, although, significantly enough, he stated it had deteriorated since enlistment one year previously.

On examination, it was noted that both corneae were definitely smaller and considerably flatter than normal. R. cornea was clear; L. cornea had fairly dense central nebulae. In both eyes the corneo-scleral junction was ill-defined, the sclera seeming to encroach on the cornea. (Barkan and Borley speak of "indistinct corneal opacity extending from the corneo-scleral margin into the corneal tissue"). The anterior chambers were shallow.

Under cycloplegic.

* Received for publication, March 21, 1944.

NORMAL CORNEA PLANA



R. vision $\bar{c}$ $\frac{+10{\cdot}50 \text{ D.Sph.}}{+1{\cdot}50 \text{ D.Cyl. Ax. } 60^\circ} = \frac{6}{36}$

L. vision $\bar{c}$ $\frac{+12{\cdot}00 \text{ D.Sph.}}{+1{\cdot}00 \text{ D.Cyl. Ax. } 90^\circ} = < \frac{6}{60}$

Lens and vitreous were clear R. and L. Fundi normal. The tension was normal in each eye.

Photographs were taken of a normal eye, to act as control, and of the abnormal in as nearly the same relative positions as possible. An attempt was made also to secure the same degree of magnification in all photographs. From a comparison of the two sets of photographs the following points relative to cornea plana may be noted:—

1. The globe is approximately of normal size.
2. The cornea is definitely smaller than normal.
3. The line of corneo-scleral junction has lost its sharp definition.
4. The curvature of the cornea is the same as that of the sclera.

The condition of cornea plana is regarded as a familial one being probably transmitted as a Mendelian recessive character (Duke-Elder). In this case, nil of importance could be elicited from the Family History.

I wish to thank Brigadier G. I. Scott, Consultant Ophthalmologist, Middle East Forces, for kind permission to publish these notes.

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THE EFFECTS OF FARADICALLY INDUCED CURRENTS UPON THE EXTRINSIC AND INTRINSIC OCULAR MUSCULATURE*

A Clinical Self Experiment

BY

Major J. HORTON YOUNG, R.A.M.C.

ALTHOUGH the effects of faradism upon the extra-ocular muscles have been noted by previous observers, the information at my disposal was not sufficiently detailed for my own satisfaction. In fact, this subject is rather avoided in text-books, whether they are ophthalmic, electrical, therapeutic or physiological manuals. In the circumstances two simple clinical experiments were

* Received for publication, November 1, 1943.

designed to clear up this matter, the results being incorporated in this article.

The aim of these experiments was straightforward enough and limited in scope, but the ensuing phenomena, being somewhat widespread and complex considering the nature of the tests, proved less easy of interpretation than was expected. This latter fact has induced me to publish these experiments, as it was felt that other ophthalmologists may find interest in placing their own interpretation upon the clinical signs and symptoms elicited. The information may also be of use to physiologists.

In analysing the results an attempt has been made to explain the clinical data in terms of applied physiology. Some of the opinions expressed are at variance with acknowledged opinion on this subject, and are given with all due diffidence. Where possible such expressions of opinion are supported by argument which, being of a clinical nature, cannot be conclusive. It is hoped, however, that this article may revive interest in faradism and the ocular musculature.

Being abroad on active service at the time of writing, the number of references at my disposal is limited, and in consequence it has been impossible to uphold fully the golden rule of scientific precedent. The design of the experiments and the experimental data embodied in this paper are therefore self-limited, and as such form an original work.

In undertaking the experiments outlined below, I did so with the object of studying the clinical effect of induced faradic currents upon the extrinsic muscles of the eye in an effort to discover whether it was possible to exploit this electrical medium on a therapeutic basis for the cure of ocular anomalies. The effects of faradism upon the intrinsic ocular muscles and the plain muscle of the orbit were complementary phenomena of unexpected severity, which proved most interesting, if somewhat painful.

Faradic stimulation of the left internal rectus muscle was decided upon, using the Smart-Bristow coil. This particular instrument was chosen because it permitted the use of minimal currents which could be easily controlled by the operator.

The Smart-Bristow coil consists of a dry cell operated electrical induction circuit in which a solenoid has been inserted in the primary circuit in association with a controlled " make and break " oscillator. The secondary unit is tapped in four places. Both electrodes arise from the secondary circuit, which carries the induced currents to the side elected for stimulation. The electrode applied to the globe is called the active electrode. In order to increase the strength of the induced currents an iron core is inserted in the primary circuit. Half the iron core was used in these experiments. The " make and break " of the primary circuit

was set at about 70-80 oscillations per second. One layer of wire from the secondary coil was employed to obtain the very minute currents for the experiments. A fine circular metal disc electrode, five mm. in diameter, covered in chamois and moistened in saline, was used for the active electrode, while the non-active electrode was placed on a saline pad and attached to the left arm. By a makeshift arrangement the ocular electrode was made to point at right angles to the insulated hand electrode, on which there was an additional safeguard in the form of a thumb-operated contact breaker.

As this was a self-experiment it was imperative to note as quickly as possible, on an available standard clinical instrument, any resulting phenomena. For this reason the Maddox Wing test was chosen for registering the amount of contracture of the rectus internus, while the degree of spasm of the ciliary muscle was estimated by the strength of minus lens required to render the left eye emmetropic for distance.

In order to simplify the tabulation of results all visual estimations in these experiments were made with the refractive error corrected by the appropriate lenses. In the case of the Maddox Wing test, where the letters were not clearly seen owing to ciliary spasm or paralysis, a white arrow was made to slide above the numbers until it coincided with the white arrow visible to the right eye. With correction the author registered four to six prism dioptres of exophoria on the above instrument. Vision with correction in both eyes was 6/6 and J.1, the right eye being the master eye.

At the first experiment five applications of induced current were made of approximately three seconds duration and at one and a half minute intervals. The site of election for stimulation was over the left internal rectus muscle, the centre of the disc electrode being 10 mm., posterior to the medial limbus of the cornea.

The primary application was performed under 5 per cent. cocaine anaesthesia as a local instillation of the conjunctival sac. As the result of the experience gained in the first test the second trial was conducted under cocaine anaesthesia and *homatropine mydriasis* and paralysis of ciliary body.

Experiment 1

Phenomena observed.—Despite conjunctival anaesthesia the presence of the electrode was felt as a diffuse pressure on the globe. The induced currents were of such a nature that they could not be tolerated for any long period of time, although the impulses were not strictly painful in the true sense. Electrical stimulation of the supraorbital nerve occurred, which was felt

along the main branch only. This may have been due to the fact that the upper lid was difficult to avoid in the placing of the electrode. No unusual subjective phenomena were experienced in the form of light flashes or such like, but an increasing dimness of vision began to set in about four minutes after the commencement of the experiment. This dimness was relative and affected the distance vision only; close print was read at increasingly shorter distances. This reading distance became stationary later and coincided with the complete non-transitory tetanisation of the ciliary muscle. Visual readings were then R.V. 6/6, L.V. less than 6/60; J.1 was read with both eyes at different reading distances. The amount of ciliary spasm, registered in dioptres, was 7·00, and with this correction it was possible to read 6/6 with the left eye on the Snellen's chart. At the peak of the spasm headache developed, which was most severe and constant and resembled migraine in its intensity. This continued for an hour and a half until the ciliary spasm was released by a mydriatic, when the headache faded as quickly as it came.

During the application of the current it was possible to watch its effect on the oculomotor activity, and nystagmoid movements were observed in left eye which were slow in relation to the rate of " make and break," about 1:30.

Coincidently with the onset of headache there was a series of remote phenomena associated with vomiting. These were nausea, excessive salivation, altered gustatory sensibility whereby there was a saline metallic taste in the mouth such as is experienced by placing the terminals of an electric battery on one's tongue. The excessive reverse peristalsis followed nausea. The vomiting was not projectile in type. It would seem that this train of symptoms was the direct result of the severe cephalalgia, the pain and/or proprioceptive impulses from the ciliary body assaulting the vagal nucleus through reflex channels. It will be noted that all these symptoms are of parasympathetic origin, and as such must have been due to the sensory impulses affecting the *dorsal* nuclei of the seventh, ninth and tenth cranial nuclei. During the course of the experiment other signs developed. The most dramatic of these was the exophthalmos (unilateral) of a non-transitory type which lasted for six hours, disappearing only under the influence of sleep. All the eye signs of true exophthalmos were present—wide palpebral fissure, lid lag on downward movement of the globe, etc., but there did not appear to be any true proptosis. This last factor was difficult of self determination. The exophthalmos was due to the stimulation of the plain muscle of the orbit through the mediation of the sympathetic system, and was tetanic in type. The pupil also dilated, but this was sub-maximal in extent, and contracted under the action of the direct light reflex.

The conjunctival vessels at the point of stimulation were dilated ("Triple response of Lewis"), while the rest of the conjunctival vessels were constricted.

Repeated tests on the Maddox Wing test showed that there was an increasing toning up of the left internal rectus muscle until the figure 2 prism dioptres of exophoria were registered. This muscle spasm was also of the tetanic type and of a transitory nature, being resolved by the conjugate movement of the eyeballs in the direction opposite to that of the contraction of the left internal rectus muscle. It is to be particularly noted that no other extrinsic ocular muscle was induced to contract. A general tetanus of all these muscles would not have altered the Maddox Wing figure. If the third somatic nucleus had been stimulated the left globe would have moved up and in, with a corresponding deviation being registered in the vertical meridian on the Maddox Wing test. There is, therefore, some local regional mechanism which controls the tone of these extrinsic muscles, since faradism does not act by local stimulation of muscle. In the circumstances the effects must have been brought about by the mediation of the autonomic system, in all probability the sympathetic supply, since apart from the parasympathetic response given by the ciliary muscle, the remaining primary phenomena were due to sympathetic stimulation. It may be argued that this increase in tone was due to the coincident increase in tone of the ciliary body, but in the second experiment it will be seen that, with accommodation paralysed, the Maddox Wing figure was "0." Unilateral spasm of the ciliary body, therefore, in no way affects the accommodation-convergence reaction under these experimental conditions.

The salivary secretions were definitely in excess of the normal, and the nausea experienced was probably due to the stimulation of the parietal cells of the gastric mucosa, with an excessive production of HCl.

At no time was vertigo experienced and there was no hyperacusis. The pulse rate was not taken.

Convergent strabismus of the accommodative type did not occur, even when the right eye was focused for close work, but, if the accommodation of the right eye was made to reach an excessive figure by placing a six dioptre minus lens in front of this eye and then voluntarily contracting the ciliary muscle to the utmost, 6/6 vision could only be achieved at the expense of an internal strabismus, the action of the internal rectus muscle under these conditions being necessary before full accommodation could be obtained from the right eye. Thus the relationship of the accommodation and convergence was seen in all its peculiarity, one eye in a state of ciliary spasm without any effect upon the internal

rectus of the same side, while the other non-paralysed ciliary body was able to function independently, but under conditions of maximum *voluntary* accommodation strabismus resulted. This strabismus was a necessary concomitant to the complete effectivity of the ciliary muscle; without this, maximum accommodation could not be achieved.

Experiment 2

Phenomena observed.—In this second experiment the ciliary muscle was paralysed beforehand with homatropine solution, cocaine anaesthesia being employed as before. The object of establishing mydriasis before the commencement of the experiment was, first, to overcome the uncomfortable subjective phenomena resulting from ciliary spasm, and so permit a greater current application to the left internal rectus in the hope that a more permanent contracture of this muscle might be produced. Secondly, to prove that the exophthalmos was due to spasm of the plain muscle of the orbit, and that this spasm was induced by the stimulation of the sympathetic system as the direct result of the faradisation. Thirdly, to show that the secondary phenomena were the result of sensory impulses originating in the ciliary muscle, and that, as the dorsal nuclei only of certain cranial nerves were involved, the dorsal longitudinal bundle must carry a separate strand of nerve fibres to bring about these reflex autonomic clinical symptoms. Fourthly, to indicate the complete unilateral *regional* independence of the accommodative mechanism as distinct from the convergence faculty of the eyes. This latter point is important in man in view of the close clinical, anatomical, and physiological relationships of the rectus internus, ciliary body, third cranial nerve and the other cranial nerve nuclei in relation to the third and their dorsal connector cell masses and the dorsal longitudinal bundle. While all points have not been fully proved by the experiments, much information has been gained.

The results of the second experiment showed clearly that the exophthalmos was due to the stimulation of the sympathetic system, as only those muscles supplied by this particular system were induced to spasm. The response obtained from the left internal rectus muscle was greater than in the first experiment, the reading of the Maddox Wing test registering "0." As before, conjugate movement of the eyes released the spasm of this muscle and the globes took up the position held prior to stimulation. As the ciliary body was already paralysed, the increase in the tone of the muscle must have been due to stimulation of its sympathetic supply. If the third nerve had been stimulated as a whole the left globe, under the action of the muscles supplied by this nerve, would have turned up and in.

No secondary phenomena were experienced, proving that, as in the first experiment, these effects were the result of sensory impulses arising in the tetanised ciliary muscle.

Summary of Signs and Symptoms

For this purpose the results have been divided into primary and secondary phenomena. This is the applied neuro-physiological division into which they naturally fall, the exception being the primary tetanisation of the ciliary muscle in Experiment 1, due to parasympathetic stimulation.

(A) PRIMARY PHENOMENA.

(1) Lewis's "Triple response" elicited at the site of stimulation.
(2) Conjunctival blood vessels elsewhere constricted. (Non-transitory.)
(3) Exophthalmos induced by faradisation. (Non-transitory.)
(4) Nystagmus similarly induced.
(5) Tetanisation of all the plain muscle of the orbit. (Non-transitory.)
(6) Tetanisation of the ciliary body. (Non-transitory.)
(7) Accommodative myopia produced by ciliary spasm.
(8) Equivocal contracture of the pupillary musculatures. (Transitory.)
(9) Equivocal contracture of the left internal rectus only, all other extraocular muscles quite unaffected. (Transitory.)
(10) No visual "black-out," presumption being that the retinal and choroidal vessels were unaffected by faradisation.
(11) Marked stimulation of the sympathetic system.
(12) Parasympathetic stimulation only in respect of the ciliary body, except as an expression of secondary phenomena resulting from the tetanisation of the ciliary muscle. (Vide *infra*.)
(13) Hemicranial cephalalgia induced by the spasm of the ciliary muscle.
(14) Sensory phenomena elicited at the site of stimulation despite 5 per cent. cocainisation of the conjunctival sac.
(15) Homatropine completely inhibited the effects of faradisation upon the pupillary and ciliary musculature.
(16) Cocaine was incapable of achieving this result.
(17) Spasm of and relaxation of the ciliary muscles seen independently in the left and right eyes respectively.
(18) Complete regional independence of the ciliary muscles and the internal recti shown.
(19) Full contracture of the right ciliary body, by the intervention of cerebral cortex (volition), in association with the left ciliary spasm, resulted in accommodative strabismus.

(B) SECONDARY PHENOMENA.

These effects were the direct result of certain sensory impulses originating in the tetanised ciliary muscle affecting the parasympathetic nervous system. It will be seen from the nature of these signs that the refluent stimuli affected the dorsal connector cell masses in close relation to the somatic cranial nuclei of the third, seventh, ninth and tenth cranial nerves.

(1) Gustatory sensibility altered as regards strength of stimulus and nature of the taste sense.
(2) Increased salivation.
(3) Sweat glands of the forehead stimulated.
(4) Probable increase in the gastric secretions resulting in the nausea. (?HCl.)
(5) Hypermotility of the stomach musculature. Partly nervous in origin and partly due to the effect of the reflex increase in the gastric secretion affecting muscular tone.

Discussion

For the purposes of more facile presentation the various clinical signs elicited in the experiments will be discussed seriatim in the order of their importance. With regard to the autonomic responses, the discussion is divided into (1) those responses discovered in experiment Two, and (2) those obtained in experiment One; experiment Two will be discussed first, as the autonomic responses elicited in this test were common to both experiments. A preliminary analysis shows that in experiment Two the autonomic responses were the result of stimulation of the sympathetic system, while in experiment One this same result occurred, but had superimposed on it the stimulation of the parasympathetic supply to the ciliary body, with its attendant train of secondary phenomena all referable to the cranial division of the parasympathetic system.

(1) Neurophysiological Interpretation of the Autonomic Responses

(1) EXPERIMENT TWO.—In this test the autonomic impulses were transmitted through the efferent pathways of the sympathetic system, the excitor cell station being in the superior cervical ganglion. From this centre the post-ganglionic fibres proceed via the carotid and cavernous plexuses to their terminations in the various muscles and blood vessels. It is noteworthy that while both plexuses were involved in the production of the clinical signs of this experiment, the choroidal and retinal blood vessels, whose musculature is supplied by these same routes, were unaffected, and there was no amaurosis. The plain muscles involved in this experiment were the rudimentary muscle of Müller, the superior and inferior tarsal muscles and the small slip of plain muscle which is incorporated in the levator palpebrae superioris. In addition the musculature of the blood vessels of the conjunctiva was involved. The fact of the "sparing" of the retinal and choroidal blood vessels is difficult of explanation, and it must be assumed that intervening subsidiary excitor cell stations, placed in the path of the impulses passing along this sympathetic network, were sufficient to insulate this particular section of the pathway against harmful or excessive impulses which might affect the efficiency of the visual apparatus (vide infra-retinal circulation).

(2) EXPERIMENT ONE.—In this test the nature of the clinical symptoms elicited gives a key to the whole response. A brief summary of these effects has been given (vide supra), which should be analysed in relation to these phenomena.

The parasympathetic responses are referable to the cranial

division of the parasympathetic system and, briefly stated, the dorsal nuclear cell mass ("connector cells") of the third, seventh, ninth, and tenth cranial nuclei were involved, the somatic equivalents being unaffected. These "connector cells"—the homologues of the posterior and the lateral horn cells of the spinal cord—communicate with the excitor cell stations of the parasympathetic system outside the brain proper. Depending in what manner the excitor impulse is distributed after leaving these centres, the symptoms will vary according to the strength of stimulus and the resistance experienced by this impulse as it flows along the numerous diverse ramifications of the parasympathetic nerve fibres. It will be evident then, that with clinical effects of such limited distribution, these connector cell masses on both sides of the brain must be in very circumscribed neuro-physiological relationship. This suggests that, while the dorsal longitudinal bundle is a very composite bundle with many connections within the brain, the parasympathetic system has developed within this bundle its own set of communications, discrete and separate from the rest of the bundle proper, a specialised "tractus para-sympatheticus cranii," as it were, to serve the intricate reflex mechanisms connected with the cranial division of the parasympathetic system. The evidence in favour of this is negative, viz.: (*a*) No effects traceable to the somatic cranial nuclei of the related dorsal nuclei were found; (*b*) the limited nature of the responses; (*c*) there is no other nervous pathway known which could produce these symptoms without introducing a more complicated clinical picture than that shown.

The sympathetic responses common to both experiments have already been discussed, with the exception of the reaction of the left internal rectus, which is also claimed as a sympathetic response. In both experiments this muscle underwent transitory increase in tone, which was abolished by conjugate movement of the eyeballs in a direction away from the movement of contracture. This may be claimed as a somatic response by some, but if the clinical data are analysed it will be seen that there was (1) no upward component in the movement of the globe, which one would have expected if the third cranial nucleus was stimulated, *i.e.*, contracture of all those extrinsic ocular muscles except those supplied by the fourth and sixth cranial nerves. (2) That if the third, fourth, and sixth cranial nuclei were involved together, the increase in tone of all these muscles would have maintained the Maddox Wing findings at their original figure. (3) There was no diplopia for reading in the first experiment and none for distance in the second experiment. Ruling out the somatic nuclei, the increase in tone must have been due to (*a*) autonomic stimulation, or (*b*) local stimulation of the actual muscle fibres. It is known

that faradisation does not affect contracture of muscle by stimulation of the actual muscle fibres, so that the contracture was produced through the mediation of the autonomic system, in all probability the sympathetic system, since the other plain muscle contractures were affected through this same system, by means of the efferent impulses arising in the superior cervical ganglion. For reasons previously stated the left internal rectus muscle only was stimulated to contract, hence each individual extrinsic ocular muscle must have a cell unit in the cervical sympathetic ganglion, thus introducing a local autonomic reflex control of extrinsic ocular muscle tone.

(2) Tetanisation of the Orbital Plain Muscle. (Non-transitory Contracture)

Halliburton and McDowell state that plain muscle cannot be tetanised, but it has been shown that all the plain muscle of the orbit underwent tetanic contraction which lasted for a minimum of six hours, resolving only under the influence of sleep. These contractions were of a painless nature, with the exception of the ciliary muscle, which was most painful.

The question of biochemical effectors at myoneural junctions is dealt with later, but it is important to note here the relation of the biochemical effectors and the nerve supply to the tetanised muscles, as it not only throws light on the mode of tetanisation, but incidentally gives a clue to the nerve supply of the ciliary body, about which there is still some doubt. With the plain muscle of the orbit the biochemical effector liberated at the muscle terminations of the sympathetic system was adrenalin, while acetylcholine was liberated at the parasympathetic nerve endings in the ciliary body. In each case tetanisation resulted. The pupil, however, gave an equivocal response, due to the fact that the sympathetic and the parasympathetic systems were represented in this portion of the eye, with its two opposing types of plain muscle and their physiologically opposed biochemical effectors. For this reason the view put forward that the ciliary body has no sympathetic supply seems well founded, the contraction and tone of this muscle being controlled solely by an acetylcholine threshold maintained by parasympathetic activity. As the volitional control of the ciliary muscle is via the third cranial somatic nucleus there is no conflict of effector action, since the biochemical effector in this case is also acetylcholine.

Finally, one sees that the plain muscle of the orbit obeys the "all or none law" with respect to the whole muscle under faradisation, *provided that the plain muscles involved are innervated by only one section* (sympathetic or parasympathetic) *of the autonomic system.*

(3) *Exophthalmos.*—All the characteristic signs of this were present in the left side only. Slight dilatation of the pupil, wide palpebral fissure, lid lag on downward movement of the globe, exposure of the sclera, above and below the cornea, were present, but there was not true proptosis of the globe (as far as I was able to judge). This exophthalmos was present in both experiments, and in no case could it be resolved except by sleep. The contractures of the muscles inducing this condition were proved to be painless, since, apart from the electrical sensations at the site of stimulation, there were no other painful impressions in the second experiment.

(4) *Nystagmus.*—During the progress of the experiments a regular lateral nystagmus took place, which was composed of a sharp medial movement of the stimulated left internal rectus and a slower recoil. The rate of nystagmus was much slower than the electrical oscillations operating in the electrical circuit under the influence of the " make and break " mechanism. The nystagmus was unilateral, and at no time was vertigo experienced in association with this phenomenon. This result was probably due to the mediation of the autonomic system. Faradic nystagmus must therefore be added to the long list of causes of nystagmus.

(5) *Lacrimatory " suppression."*—There was no production of tears during or after the experiment, which one would have expected as a simple protective mechanism, apart from the known fact that the lacrimal gland is supplied by the sympathetic system. One can understand the anaesthetisation of the conjunctiva producing this under conditions of simple local stimulation of the conjunctiva or cornea, but when the electrical impulses were distinctly felt, the " triple response " of Lewis was obtained, and there was general stimulation of the sympathetic system in the greater part of the orbital area; the lacrimatory " suppression " is difficult to understand.

(6) *Retinal circulation.*—Although there was marked sympathetic stimulation of the excitor cells of the superior cervical ganglion, this in no way affected the calibre of the retinal and choroidal vessels, since at no period of the experiment was there any amaurosis, vision 6/6 with a myopic lens and J.1 at short distance without any correction. It is apparent that there are subsidiary excitor centres for these intraocular vessels either within this ganglion or elsewhere in the path of the sympathetic impulses. If this last is the case, it is probable that the impulses from the superior cervical ganglion were unable to liberate a " synaptic transmitter " at these excitor cell stations, and that sufficient resistance was introduced in the path of the impulses to insulate the blood vessels against these excessive and foreign stimuli produced by faradisation. It illustrated, however, the

wonderful insularity of the synaptial junctions, which in their way act as protectors of vital tissue against the numerous impulses which pass along the sympathetic chain during the course of one's existence.

(7) *Antidromic response.*—Despite the removal of the exteroceptive sensory stimuli by cocainisation of the conjunctiva, the electrical stimuli and/or trauma, produced by pressure of the electrode on the left globe, was sufficient to evoke the "Triple response" of Lewis.

(8) *Biochemical effectors at the synaptial junctions.*—It is believed that the liberation of acetylcholine at the synaptial junctions is responsible for the transmission of a nerve impulse across a synapse. If this is so, the acetylcholine threshold for these junctions must differ with the section of the nervous system undergoing stimulation as well as for the particular tissue supplied by the nerves involved, since we have seen that, although the autonomic nerves conveying impulses from both the carotid and cavernous plexuses were involved, certain structures supplied by these self-same nerves were not stimulated. The classic example was the lack of response exhibited by the retinal and choroidal blood vessels of the left globe.

(9) *Biochemical effectors at the myoneural junctions.*—Where plain muscle of the orbit is concerned (inclusive of the ciliary muscle), both acetylcholine and adrenalin appear to exert an equal power, in that they are both capable of inducing tetanus in these muscles, *provided that the two biochemical effectors are not represented in the same muscle.* Where they are both represented in the same muscle adrenalin appears to possess priority in what might be termed "the Power Table of Humoral Precedence" under the conditions of this electrical experiment. This priority, however, was but temporary, since the contractures initiated by adrenalin are readily overcome by acetylcholine liberated reflexly, through the parasympathetic system, *e.g.*, as seen in the equivocal pupil response or in the reduction of the spasm induced in the left internal rectus by the volitional act of conjugate movement of the globes, through the intermediary of the third cranial somatic nucleus of the same side. The only exception to these rules was the musculature of the conjunctival vessels, which exhibited dilatation at the site of stimulation and the constriction elsewhere of a more permanent nature.

(10) *Pain impulses.*—The cephalalgia which accompanied the tetanisation of the ciliary body has been described (*vide supra.*). It remains to analyse the reason why pain occurred in this case and not in the case of the tetanised plain muscle of the orbit.

The threshold for pain in the ciliary body appears to be less than that for the other ocular muscles. This threshold factor may

have been lowered by the contracture of the ciliary muscle reducing the size of the blood vessels, and so producing stagnation of the pain producing substance " P " of Lewis, which, accumulating rapidly, inversely affects the pain threshold. On the other hand, the situation is complicated by the fact that the acetylcholine liberated in the muscle under stimulus should have been more than necessary to counterbalance this diminution in the vessels. The alternative postulate is that the sympathetic activity which caused contracture of the conjunctival blood vessels produced a similar contracture of the vessels of the ciliary body, quite independent of the biochemical effector acetylcholine which mediated in the contracture of the ciliary muscle. This latter explanation is probably the correct one, although it is difficult to imagine the choroidal vessels being " spared " in these circumstances.

(11) *Conditioned reflexes.*—The relation of the ciliary body to the dorsal cranial nuclei of the seventh, ninth, and tenth cranial nerve nuclei having been demonstrated in these experiments, it shows how easily migraine may develop as a conditioned reflex in subjects with inherently unstable vasomotor systems, the overflow of impulses from any organ in relation to the cranial division of the parasympathetic system spreading from their localised tracts in the above system to the vasomotor supply of the cerebral vessels, resulting in dilatation and hemicrania.

(12) *Tetanisation of the left internal rectus muscle.*—The extrinsic ocular muscles are capable of voluntary contraction, but their physical properties on histological analysis show them to be quite different from skeletal muscle. Moreover, their reactions under certain experimental conditions also differ in a similar way. The muscles appear to have properties akin to the plain as well as the skeletal muscle. In these experiments tetanisation of the left internal rectus muscle was produced, which did not resolve when the faradic stimulation ceased, but was " broken " by the conjugate movement of the eyeballs in a direction opposite to that of contracture. In view of the above facts and the proved marked sympathetic reaction following faradisation, together with the absence of reaction of any of the other muscles supplied by the third somatic cranial nucleus, one must conclude that the tetanisation of the left internal rectus muscle was due to stimulation of the sympathetic system.

Recommendations

Should this paper arouse sufficient interest in other investigators to perform more detailed research in respect of faradically induced currents and the ocular musculature, certain precautions should

be observed. These relate to the persons on whom the experiments are to be performed and the possible further reaction which may affect the eye with more sustained applications.

With personnel: (1) One should avoid performing the experiments continuously on the same subjects. (2) Experiment on one eye at a time and alternate the days on which the tests are made. (3) Take certain clinical precautions with regard to the ocular health of the patient. These conditions are listed under contra-indications below.

With induced faradic currents: (1) Under increasing strength of current it may be possible to cause spasm of the retinal and choroidal arteries with a resultant retinal and choroidal ischaemia resulting in blindness, as the spasm of the delicate ocular vessels is very intense and constant. This is well seen in the conjunctival vessels, which were still in a state of spasm six hours after the experiment. Should this occur the therapeutic application of a sub-conjunctival injection of acetylcholine (5 mm. of B.D.H. solution) may remove this spasm and improve the blood supply, as this effector in therapeutic concentrations is a violent anti-spasmodic of the vessel musculature.

Contra-indications.—(1) Age. An healthy young adult is the ideal subject for the experiment. Arteriosclerosis from any cause would be a definite bar to this form of investigation, as the changes induced in the vessel wall might result in further pathology.

(2) Hereditary predisposition to nervous diseases such as migraine,

(3) Myopia. Detachment of the retina may result.

(4) Glaucoma. May precipitate an acute attack.

(5) Old trauma to the globe (even slight injuries to the cornea). An irritable eye may result from further trauma attendant on electrical stimulation.

Research

In the light of modern scientific knowledge further research into the action of faradism on the ocular muscles in certain types of muscular diseases should yield fruitful results, as the ocular muscles, with their easily recordable movements, their intricate neuronal affiliations and the differing types of effector substances acting within this limited anatomic field, make this portion of the body the research area "par excellence." Such diseases as myasthenia gravis, in which 78 per cent. of all cases have the oculomotor muscles involved, and Thomson's disease—myotonia congenita—would supply important facts, as these diseases are believed to be due to congenital aberrations of the muscle biochemistry, whereby there is an imbalance between the rate of

liberation of acetylcholine in the affected muscles and its destruction by acetylcholine esterase locally present in the muscle.

Apart from the above spheres for research, the inter and intranuclear synaptial insularity of the brain nuclei make possible the more accurate localisation of the neural pathways in the brain, since there are no irradiating electrical responses within the brain during the conduction of the delicate induced currents.

General Summary

(1) A short description of the Smart-Bristow electrical induction apparatus is given, together with the very simple modification required to undertake the experiments previously outlined.

(2) The phenomena resulting from faradic stimulation of the left internal rectus muscle is described in detail:—

(*a*) Under cocaine anaesthesia.
(*b*) Under cocaine and homatropine anaesthesia and mydriasis.

(3) A brief recapitulation of the experimental signs and symptoms is given under the titles of:—

(*a*) Primary phenomena.
(*b*) Secondary phenomena.

(4) The physiology of the reactions experienced in the two tests is discussed.

(5) Faradically induced electrical currents have been shown to be capable of producing three important ocular signs, namely:—

(*a*) Exophthalmos.
(*b*) Nystagmus.
(*c*) Spasm of accommodation.

} Via the mediation of the autonomic system.

(6) Some recommendations and contraindications have been laid down for other research workers desiring to undertake these experiments as a preliminary to research work of a similar nature.

(7) Under conditions of consciousness the subjective effects of faradism upon the ocular tissues prevent its use as a therapeutic agent in the treatment of the heterophorias, paralysis of accommodation and the extrinsic ocular paralyses. It is considered that with the advent of modern general anaesthesia, due safeguard as regards type of patient and strength of current used, with or without homatropine as required, it should prove useful for treating the various muscular anomalies resulting from war trauma or other cause. It should also prove useful for diagnosis and prognosis of ocular muscle lesions.

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DYNAMIC FACTORS IN THE FORMATION AND RE-ABSORPTION OF AQUEOUS HUMOUR

BY

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THE recent article by Duke-Elder and Davson,[1] discussing the work on aqueous humour dynamics by Kinsey, Grant and Cogan,[2] provides the opportunity for an exchange of views on this subject, which, I believe, will show that the area of agreement among workers in this field is now very much greater than the area still in dispute. There is apparently general agreement that some exchange of constituents occurs between blood and aqueous by a group of processes which may be summed together as diffusion, and that superimposed upon this equilibrating trend there are in addition dynamic factors which prevent the development of complete equilibrium between blood and aqueous. Duke-Elder and Davson sum these dynamic factors together as secretion. Kinsey and Grant attempt to separate the dynamic factors into secretion and leak. The problem of determining the factors responsible for these deviations from equilibrium can also be approached from a detailed analysis of the secreting and re-absorbing mechanism, and it is this approach that I have followed.

So far as concerns the diffusional exchange between blood and aqueous, the determining factors must be, on the one hand the size, mobility, ionic charge, etc., of each component that is exchanged, and on the other hand, the membrane characteristics or permeabilities of the several barriers across which exchange takes place. It seems obvious that these several barriers do not have identical permeabilities. The ciliary barrier is very different from that in the iris, as has been shown by many investigators. Kinsey and Grant's hypothesis of a leakage of aqueous into Schlemm's canal is one particularised assumption that the permeability of this portion of the blood-aqueous barrier differs from that in the iris and ciliary body. There is, in fact, no reason for assuming that the permeability for each individual component of the aqueous varies in the same fixed proportion in all the different parts of the blood-aqueous barrier.

Kinsey and Grant have measured the rate of transfer from blood to aqueous of the various components of the intraocular fluid, and from these measurements have computed co-efficients of transfer for each of the substances studied. Such computed co-efficients, however, must represent only averages for

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the whole complex system, averages in which the proportion contributed by each part of the blood-aqueous barrier presumably varies for each component of the aqueous. Kinsey and Grant have indeed recognised this, and have concluded that a secretory mechanism is required to account for the observed transfer rates of electrolytes, while diffusion alone may account for the transfer rates of water and of non-electrolytes. Their studies were not primarily concerned with what tissues contributed to these several mechanisms nor how these mechanisms operate.

Duke-Elder and his co-workers, on the other hand, have directed their energies not toward the rate of transfer of individual components from blood to aqueous, but to the measurement of the concentration ratios of different components in blood and aqueous. They have shown that the aqueous is hypertonic to blood plasma, that it contains a considerable excess of electrolytes when compared with plasma dialysate. They conclude, in agreement with Kinsey and Grant, that secretory energy is required to maintain this discrepancy. They have not been primarily concerned with how secretory and diffusional forces may co-operate in the total result.

What, then, do we actually know about the secretory and reabsorptive mechanisms, and to what extent does our knowledge of these mechanisms now suffice to explain the observed rates of transfer and concentration ratios of various substances between the blood and aqueous?

The secretory mechanism in the ciliary processes has been found to be connected with the oxidative interchange between the epithelium and the stroma of this tissue.[3] Such an oxidative interchange must lead to the production of anions in the epithelium, primarily hydroxyl ions formed from the reduction of oxygen, and the production of cations in the stroma, primarily hydrogen ions formed from the oxidation of hydrogen. Concentrating our attention for the moment on the epithelium, it is to be presumed that the newly-formed anionic charge would be transferred to other ionic species by buffer action. Thus, for instance, the reaction

$$\bar{O}H + CO_2 \rightarrow \bar{H}CO_3$$

may be supposed to describe the chief overall mechanism by which the disappearance of the hydroxyl ions is effected. The aqueous, however, does not contain an excess of bicarbonate. In order to account for this fact we must, therefore, assume an exchange of bicarbonate for other anions, chiefly chloride, an exchange such as has been shown to take place with great ease between red blood cells and plasma. There is no evidence of an excess of bicarbonate even in the posterior chamber. Consequently the exchange of bicarbonate for chloride must take place

chiefly in the ciliary body itself, and the stroma-epithelium barrier must permit such an exchange.

The possibility of such an anionic exchange across the secretory barrier in the ciliary processes is a characteristic of the permeability of this barrier which had not previously been postulated, and for which no direct experimental support has as yet been obtained. Such an exchange is not necessarily a feature of every secretory mechanism. For instance, the saliva of cows is approximately isotonic with plasma in its electrolyte content and resembles the aqueous in many aspects of its composition, but its chief anion is bicarbonate, not chloride.

In the ciliary stroma, the excess hydrogen ions formed as a result of the oxidative interchange is likewise presumably disposed of by local buffering action of the tissue and by exchange of cations with the blood. In any case, a net excess of anions in the epithelium and of cations in the stroma still remains at this stage of the argument, this net excess to be balanced by an overall transfer from one tissue to the other. In the ciliary body, the barrier between epithelium and stroma is negatively charged.[3] It is well established that the layer of water in contact with such a negatively charged membrane must contain an excess of cations held there by the electrical forces of the charge in the membrane. This water layer adsorbed on the surface of the membrane is, then, positively charged because of the excess of cations which it contains, and it will be repelled by the excess cations in the stroma, attracted by the excess anions in the epithelium. Bethe[4] has, in fact, shown by direct experiment that the net ionic movement caused by the imposition of an electrical force across a charged membrane in a watery environment is furnished by the adsorbed layer, and that the fluid moved under such circumstances is hypertonic in comparison with the main body of fluid from which it is derived. Thus the portion of the aqueous which is " secreted " is the adsorbed layer on the secretory membrane.

As noted above, Duke-Elder and his co-workers[5] have shown that the aqueous is hypertonic in respect to electrolytes as compared with the blood, and conclude that secretory forces are involved. From measurements of the rate of transfer from blood to aqueous, Kinsey and Grant also conclude that electrolytes are secreted. This may, then, be taken as further evidence that it is the hypertonic adsorbed layer on the ciliary membrane which is secreted. The fluid which is transported into the epithelium may, in fact, be much more hypertonic than the aqueous, for osmotic exchange may begin to reduce its hypertonicity as soon as it reaches the epithelium. This is, again, an aspect of the secretory mechanism for which we have as yet no direct experimental data. It is within the framework of such suppositions,

however, that Kinsey and Grant's conclusion that electrolytes are secreted while water is moved by osmosis (in addition to exchange) may be understood.

Various workers (Walker,[6] Adler,[7] Benham[8] and others) have shown that the aqueous is hypotonic in respect to urea and some other non-electrolytes as compared with the blood. Kinsey and Grant confirmed this and attribute this to "ultra-filtration," or in more general terms to diffusion, assuming a differential permeability in favour of water and against non-electrolytes at the blood-aqueous barrier. Duke-Elder in his criticism of this work objects to the ultra-filtration in the absence of secretory activity. In order to filter fluid, as dilute in urea as is the aqueous, unphysiological levels of capillary pressure would be required in the absence of secretion. However, Kinsey and Grant have concluded that secretion of electrolytes takes place. (A minimum capillary pressure of 75 m.m. Hg. would be required to filter an intra-ocular fluid containing 10 m.gm. per cent. less urea than in the blood. This is approximately the normal pressure in the central retinal artery, and is 25-35 m.m. higher than estimates of intra-ocular capillary pressure based on other methods of study.) I believe that it is compatible with the arguments of both these investigators to point out that there are two ways in which aqueous hypotonic in non-electrolytes can be formed by the ciliary processes. First, it is quite possible that the adsorbed layer on the secretory membrane is itself relatively deficient in non-electrolytes. The more hydrophilic and less surface acting such substances are, the lower, proportionately, will be their concentration in the adsorbed layer. Evidence on this possibility might be obtained through a study of such substances as alcohol which have a higher tendency to be adsorbed.* At any rate, a deficiency of non-electrolytes on the secretory membrane would be a special kind of permeability factor such as Kinsey and Grant envisage. The energy required for the movement of the adsorbed layer would, in this case, be supplied by the secretory mechanism, not by ultra-filtration.

A second way in which the secretory apparatus could yield a fluid hypotonic in non-electrolytes is the following: As indicated above, the adsorbed layer on the secretory membrane is probably

*A number of investigators have shown that the concentration of alcohol in the spinal fluid tends to be higher than that in the blood. Mehrtens and Newman[9], for instance, maintained the blood alcohol level stationary for 4-5 hours by continuous intravenous infusion. At the end of this period, the spinal and cysternal fluid levels were on the average 10 per cent. higher than in the blood. Part of this excess is to be accounted for by the fact that the concentration of alcohol in plasma is higher than in whole blood, part by the fact that the water content of plasma is lower than that of spinal fluid. When allowances are made for these two corrections most investigators[10] agree that the spinal fluid alcohol concentration is in equilibrium with that in plasma,—but there is in any case no deficit of alcohol in the spinal fluid as is the case in respect of urea.

quite hypertonic in cations. When this fluid is transferred to the epithelium it is met by an equal excess of anions yielding a fluid presumably more hypertonic than the final aqueous. This fluid may now be diluted by osmotic forces. It has been shown that the secretory membrane is relatively impermeable to the passage of cations except under the influence of electrical, *i.e.*, secretory, forces.[3] It would follow that the dilution of this fluid could not occur by the diffusion of salt back into the stroma, but only by the diffusion of water from stroma to epithelium. Thermodynamic equilibrium would not be attained under these conditions, only a steady state, but the thermodynamic principle of "least work" may still be applicable, and the least work toward establishing that steady state would occur if fluid relatively hypotonic in non-electrolytes were transported. It is this concept which Kinsey and Grant favour. There are, therefore, sound thermodynamic grounds for believing that the fluid transported by this mechanism would be hypotonic in non-electrolytes. This corresponds also, I believe, to Duke-Elder's argument that energy must be supplied in order to produce such hypotonicity.

It would appear, then, that the components of the secretory apparatus so far identified, with a few additional postulated specifications, suffice to account for the formation of aqueous hypertonic in electrolytes and hypotonic in non-electrolytes. The energy both for the actual transport of the fluid and for its deviations from a dialysate is provided by the metabolic interaction between epithelium and stroma. In this sense the fluid transported may properly be called a secretion, though electrical and osmotic forces and membrane characteristics all enter into determining its final composition.

In the iris the blood-aqueous barrier consists only of capillary endothelium. There appears to be no evidence either in respect to the iris capillaries, or in respect to capillaries in other organs that secretion across the capillary wall takes place. Hence we have no grounds for supposing that anything except diffusional exchange can take place in the iris portion of the blood-aqueous barrier. Consequently, the contribution which the iris makes to the composition of the aqueous must be to bring it nearer to equilibrium with the blood plasma; that is, to reduce its hypertonicity in electrolytes and its hypotonicity in non-electrolytes. No experimental data are available by which to determine whether the equilibrating contribution of the iris is large or small, but it is presumably not negligible.

Duke-Elder and his co-workers have shown that the total osmotic pressure of the aqueous is considerably higher than the total osmotic pressure, including proteins, of the plasma. The osmotic forces acting across the blood-aqueous barrier in the iris

would therefore move water from blood to aqueous. The hydrostatic pressure in the iris capillaries is certainly not less than the intra-ocular pressure. Thus the net water transfer across the iris barrier must be from blood to aqueous. This is in accord with Kinsey and Grant's conclusion that part of the water transferred into the eye is moved by osmotic forces.

We have arrived, then, at a curious paradox. Duke-Elder's studies on the osmotic pressure of the aqueous, Kinsey and Grant's studies on the rates of transfer of the individual components of the aqueous, and my own investigations on the secretory mechanism all serve to explain in mutually compatible ways how extra water over and above the diffusional exchange enters the eye. How, then, is the volume of the eye maintained constant? Kinsey and Grant were the first to point out clearly that simple diffusion into the blood does not suffice to explain the exit of water from the eye, and have suggested leakage out of the eye as a possible way out of the dilemma.

The objections of Duke-Elder and Davson to the leak hypothesis do not seem to me to be valid. They argue that the composition of the aqueous deviates from that of the plasma dialysate by such a large factor that the hydrostatic energies of filtration plus leak do not suffice for the work to be performed, and hence that secretion is necessary. This is undoubtedly true, but the dilemma which the leak hypothesis was designed to resolve was reached only after the secretion of electrolytes into the eye had already been accepted as proven. It may be suggested that this dilemma could be equally resolved by assuming a secretion of water out of the eye. However, no organ for such secretion is apparent.

While the leak hypothesis is, then, compatible with the experimental data of Kinsey and Grant and also those of Duke-Elder, it is not the only hypothesis for the exit of intra-ocular fluid which is compatible with these data, and there are some other data which give weight to some of the alternatives.

It may be pointed out, for instance, that Leber's conception that fluid filters out of the eye into Schlemm's canal does not involve any equilibrating osmotic factors between blood and aqueous at the aqueous-Schlemm boundary, and hence would be a satisfactory alternative to a leak. There is, in fact, no way to distinguish between filtration and leak through chemical analysis of the aqueous. Duke-Elder,[11] however, has found that the pressure in the episcleral veins, with which Schlemm's canal is connected, is equal to or slightly higher than the intra-ocular pressure. If this is true, neither leak or filtration into Schlemm's canal is possible. How, then, can we escape the dilemma which Kinsey and Grant have formulated?

An alternative which is compatible with the latter's analysis is

the slow trickle of plasma into Schlemm's canal, for the existence of which I have previously presented some evidence.[12] In order to show that this is compatible with the requirements of Kinsey and Grant let me present the following illustration. If a limited volume of plasma is dialized against hypertonic salt solution through a collodion membrane, there is first a movement of water from the plasma and a simultaneous movement of salt into the plasma. After a period the salt concentration in the plasma compartment approaches that in the salt solution, and thereafter water and salt both move into the plasma compartment diluting the plasma proteins. When this stage has been established some of the diluted plasma can be removed and replaced by a small amount of fresh plasma. If the newly added plasma is given in sufficiently small amount, the osmotic transfer of fluid into the plasma compartment will not be interrupted. In fact, a continuous slow trickle of plasma and corresponding removal of diluted plasma can keep the absorption of fluid going as a steady process—all the while the absorbed fluid having a higher osmotic pressure than that of the plasma which is being added. Within limits, the rate of fluid absorption will vary with the rate of plasma supplied.

This is precisely the arrangement which histological studies have indicated is the case for Schlemm's canal, with its narrow and scanty afferent arterioles, its wide and numerous efferent venules, its content of few blood cells and diluted plasma. So far as concerns the absorption of non-isotonic aqueous, this mechanism can function as if it were a leak, but the rate of absorption can be subject to vasomotor control.

Kinsey and Grant estimate that the rate of "leak" in rabbits is 4 cu. m.m. per minute, *i.e.*, 1½ to 2 per cent. of the aqueous. This should be less than the rate of disappearance of crystalloids injected into the anterior chamber, since some of such injected crystalloids may diffuse out of the anterior chamber by other routes. The results obtained from such injection experiments are, however, somewhat lower—for instance, 1 per cent. per minute for glucose, 0·8 per cent. per minute for ascorbic acid. Whether this discrepancy indicates an error in the theory or is to be accounted for within the limits of experimental error remains to be seen.

In summary, the picture of the secretory and reabsorptive mechanism which has grown out of the histological and histochemical studies which my colleagues and I have reported, is compatible with the findings of Duke-Elder and his co-workers in regard to the constitution of the aqueous, and with the findings of Kinsey and his co-workers on the velocity of exchange of components between blood and aqueous. Similarly, the theoretical

conclusions which Duke-Elder and Kinsey draw from their studies are compatible with the details of structure and organisation which we have found in the ocular tissues.

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MUCOCELE OF MAXILLARY ANTRUM

BY

G. E. DODDS

WEST AFRICAN MEDICAL SERVICE

THE patient in this case presented himself at a native dispensary in the "bush" in Southern Nigeria.

All that could be done was to examine, photograph and endeavour to persuade him to come to hospital. Nothing further was attempted as it was hoped that at some future date transillumination, nasal examination, X-ray and operation could be carried out.

At the time the case was seen it would have been quite easy to insert an exploratory needle through the skin of the lower eyelid and doubtless a thick gelatinous fluid could have been aspirated.

Such a procedure would have undoubtedly encouraged the patient to think that a cure had been effected or would eventuate in time, and so the possibility of further enquiries would have been indefinitely postponed. A knowledge of local psychology is essential for the benefit of all concerned, and curiosity must be tempered with discretion if medical secrets are to be exposed.

Cases of mucocele in Nigerians have been seen by the writer in connection with ethmoidal cells and the frontal sinus. As no case of this type has been seen, it may prove of interest.

"In Diseases of the Nose, Throat and Ear," by A. Logan Turner, Ed., 1936, the following statement appears on page 96. "It is doubtful if a parallel condition (*i.e.*, mucocele), has been found in the antrum." The swelling in this case was situated just above the lower margin of the orbit, and could be palpated for a certain distance into the orbit. It gave the typical sensation of a fluid-containing cyst, and was but slightly moveable from side to side. The globe was displaced upwards. Apart from disfigurement and diplopia the patient suffered little inconvenience.

His photograph belies his mental outlook—he was not worried; he had no pain; it is unlikely for those reasons that he will trouble to come the 15 miles or so to hospital.

It is regretted that definite proof that this is a mucocele of the antrum has not, so far, been obtained in this case.

RETRO-BULBAR NEURITIS
(Five Cases) due to Para-nasal Sinusitis

BY

ROSA FORD

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WE see many eyes that are quite normal, with poor, sometimes extremely defective, sight. If this blindness is in only one eye, or in both with no hemianopia, the lesion must lie in one or both optic nerves, and the condition is called retro-bulbar neuritis.

That is sometimes the extent of our knowledge, and it is often necessary to tell the patient, "Your trouble is behind the eye, but we do not know what it is."

The following reports of five cases are made for the light they throw on their aetiology, and as some contribution to a very controversial and so far unsolved problem:—

CASE 1.—A man, aged 31 years, was seen in February, 1926, for defective vision in the right eye, of five months' duration. Vision was 2/60, with nothing in the eye to account for the defect. The sinuses were reported normal both clinically and radiologically, and no other possible cause was discovered. He remained under observation for fifteen months, during which time vision increased to 6/18.

He did not attend again for two years and four months, when he stated that his vision had remained exactly as on his last visit till nine months ago, when it had recovered as unaccountably as the defect had begun, and had given him no trouble since. The defect had thus lasted for over three years. Vision had become 6/9. He was not then seeking advice for his eyes but for catarrh, which was so troublesome it was disturbing his sleep. He had had post-nasal catarrh for six years, but this exacerbation had only begun nine months ago.

Recovery of sight had thus synchronised with the onset of severe post-nasal catarrh, suggesting that this spontaneous drainage of the sinuses had relieved the pressure on the optic nerve responsible for the blindness.

While the sinusitis had remained latent, *i.e.*, with secretion *retained*, retro-bulbar neuritis had persisted; when it became obvious through *release* of secretion into the nose the neuritis cleared.

CASE 2.—A woman,[1] aged 31 years, with defective vision for the last two months. Vision was 6/18 in each eye, and the fundi and media were normal. The cause was obscure. Five months later, with vision still 6/18, an exploratory syringe withdrew pus from the left sphenoidal sinus and cloudy mucus from the right. There was nothing at all obvious about this sinusitis, for there had been no catarrh, and two surgeons had declared the nose particularly normal, both in bony formation and appearance of the mucous membrane. When it became obvious, after operation and treatment, the retro-bulbar neuritis cleared and vision finally became 6/6 in each eye.

CASE 3.—A woman,[2] aged 39 years, with defective vision in both eyes. Right vision had never been above 6/12 for three years, and left vision had been $< 6/60$ for the last six months. She had been under expert ophthalmic, rhinological and neurological advice for seven years, but the cause had entirely escaped detection because the nose gave no sign of sinus infection either clinically, radiologically or even to proof-puncture, and there had been no catarrh.

With intra-nasal medication free catarrh developed, and vision rose in seven weeks to 6/6 in the right eye and 6/24 in the left, the remaining defect being due to a patch of choroidal atrophy which involved the macula.

CASE 4.—A woman,[3] aged 31 years, whose right vision had been defective since two years old. She could count fingers at one foot, but only in the outer part of the field. With fundus and media normal and some convergent strabismus, the eye had been deemed "lazy," and none knew why.

The field showed a large and intense upper scotoma, wedge-shaped, extending from the periphery to its apex just below the fixation point, thus cutting off central vision.

There had been nothing to suggest any implication of the sinuses in the amblyopia, for there had never been any catarrh, and there was no definite radiological evidence of sinusitis.

With intra-nasal medication free muco-purulent catarrh developed, and an indication of returning sight came when the patient could see her right arm swinging as she walked, for the first time in her life.

In eight months the scotoma had become progressively narrower and less intense, so that while at first no hand movements could be seen in its area, a 20 mm. white object later became visible, and then a ten and a six, except for a narrow central core extending to only 11 deg. above the fixation point.

In 14 months the scotoma still existed, but only for a 3 mm. white object,

and this just crossed the fixation point, so that the patient saw an object best by looking slightly above it. In this way she was finally able to read a few words of J.1; and vision was 5/60.

The slowly progressive lightening of the scotoma, as the result of continuous drainage of the sinuses, indicated the very gradual subsidence of the oedema surrounding the inflamed sinuses.

CASE 5.—A woman, aged 62 years, who had suddenly become blind in the left eye two years before. Central vision was <6/60, and there was a large scotoma extending from the lower periphery to 20 deg. above the fixation point.

The only clues to sinus disease as the cause were:—

(1) Markedly contracted fields.

(2) Evidence of toxaemia in her insomnia, fatigue, headache, depression and irritability.

(3) Evidence of marked congestion at the back of the eyes, causing such severe photophobia that she only went out at night.

With intra-nasal medication free post-nasal catarrh developed, and within three months all her toxic symptoms and the photophobia had vanished, and the scotoma had shrunk to a small central area extending no further than 10 deg. from the centre.

Retro-bulbar neuritis often recovers spontaneously, and this has frequently led to the adoption of a waiting policy. That this is dangerous "wishful thinking" is shown by this patient's two years of blindness and ill-health, and the fact that, though health has been restored, there is still a small central scotoma eight years after her first attendance.

The entire absence of catarrh had misled the two ophthalmic surgeons previously consulted, who had thus been unable to give her any help.

To these cases may be added the description given by Nettleship[4] of an analogous condition in a Jersey heifer. The animal had suddenly become blind and ill without any ascertainable reason. On the third day a profuse muco-purulent discharge from the nostrils occurred and was followed by gradually restored sight and health.

A case reported by Sandford[5] shows to what an extreme degree sinus disease may proceed and yet give no evidence of its existence except by blindness. The man died, and at post-mortem a broken-down sphenoidal sinus was found, from which a subdural abscess had spread across the middle fossa and was pointing externally in the temple. There had been nothing to indicate this during life but optic neuritis in both eyes for the last two and a half years.

Comments

The five cases now reported, showing recovered vision after defects lasting in some as long as 2, 3, or even 29 years, point less to a neuritis than to pressure on optic-nerve fibres analogous to that exerted by a pituitary tumour, removal of which even after prolonged pressure on the optic nerve is followed by restored sight.

The optic canal through which the nerve reaches the orbit is in close relation to the sphenoidal and/or the posterior ethmoidal sinuses. It is within the bony margins of this canal that the nerve can be subjected to pressure. If this pressure were due

to septic exudation from the sinuses there could hardly fail to be an extension of inflammation to the nerve itself, in spite of the protection of its dural sheath, during these long periods of close contact, *i.e.*, an actual neuritis. Visual improvement in these cases, however, was so prompt and progressed so steadily as drainage continued that a gradual subsidence of chronic oedema surrounding the sinuses and compressing the nerve in its canal is the more likely explanation.

This steadily progressive return of sight is graphically demonstrated in the field charts[3] of Case 4, in which the large and intense scotoma is seen gradually to dwindle both in size and intensity during a period of 14 months' continuous drainage.

The term "retro-bulbar neuritis" is thus scarcely a correct description of the condition, and might more accurately be replaced by the term "*pressure paresis of the optic nerve.*"

There are many degrees of this paresis. In these five cases it was severe, but slighter pressure is common, and many eyes are called "lazy" because they fail to see 6/6 with no apparent cause for the defect. In most such cases the amblyopia will be found to disappear when means are taken to secure adequate drainage of the sinuses.

Retro-bulbar neuritis is said to be very rarely the result of sinus disease, and then only when the latter is obvious.

These cases show that, on the contrary, it is when the sinusitis is *hidden, i.e.*, when secretion is *retained,* that retro-bulbar neuritis develops; as soon as it becomes obvious, either spontaneously or by nasal drainage, the retro-bulbar neuritis tends to disappear.

It was this peculiar characteristic of sinus disease, to remain "silent" for prolonged periods, even when infection was active, that accounted for the previous failure to arrive at the correct diagnosis in all five cases.

"Silent" sinusitis has remained unmasked for many decades because methods of diagnosis and treatment have been inadequate.

Though diagnosis cannot be made by clinical examination when there is no catarrh, and often even radiology and proof-puncture are unhelpful, it can be made, as it was in most of these cases, by the fields of vision, aided by a careful study of the history and past history, even without the help of the more inconvenient methods of culture of sinus washings after the method of Watson Williams, or a lipiodol X-ray.

Treatment by resection of the septum, and even opening of the sinuses, may give little or no confirmation of the diagnosis. A freed air passage does not necessarily free the sinuses. One infected sinus missed may queer the result, and even if opened may close again. Nothing is adequate but the effective *continuous*

unloading of the sinuses, which occurred spontaneously in one case, and was obtained in the others by appropriate intra-nasal treatment.

The gradual widening of the fields as the sinuses are drained is a source of satisfaction and encouragement to the patient, who finds in it a visual record of his progress, and the gradual disappearance of his toxic symptoms makes him the more willing to persevere.

As the sinusitis in all these cases escaped detection for long periods, in some even for years, and only became evident through the unloading of its secretion, it is not unreasonable to surmise that the same may be true of many another unexplained case of retrobulbar neuritis. The large percentage of obscure cases may thus be substantially reduced, if not altogether eliminated.

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RECONSTRUCTION OF THE LOWER LID BY HUGHES' METHOD*

BY

JOHN FOSTER

LEEDS

LOCALLY malignant neoplasms of the lower lid, unless thoroughly treated in the early stages, may start a train of consequences ending in evisceration of the orbit. Such cases, though rare, are still occasionally seen.

In a day when operations on the lacrymal sac are delegated to rhinologists, those on the lids to plastic surgeons, and those in the orbit to the neuro-surgical fraternity, it is a pleasure to pay tribute to an operation on the ocular adnexa, which not only deals effectively with such a serious condition, but is both purely ophthalmic, and relatively simple.

It is relatively easy in principle if the lower lid is destroyed or removed, to find enough skin to restore the outer layer from the cheek, and enough bulbar conjunctiva to restore the inner layer from the eye. The intermediate layer of lashes and tarsal cartilage, however, are more difficult to replace. Hughes' procedure (an

* Received for publication, May 3, 1944.

elaboration of those of Landolt and Dupuy-Dutemps) accomplishes this.

The inventor demonstrated the procedure by cinema film in New York in 1938 to the North of England Ophthalmological tour, of which I was a member. A full description is given in the *Amer. Arch. of Ophthal.*, 1937, p. 1008.

As, judging by conversation, this operation is still little employed in this country (probably because the account in the Archives makes it appear more difficult than it really is) I felt that it might be of interest to others to record two cases dealt with in this manner.

In both these cases the left lower lid had to be removed almost entirely, on account of a basal cell carcinoma, which the Radium Department felt was unsuitable for irradiation. In the man's case the right eye was amblyopic.

The first stage of the operation is removal of the growth, and the line taken by the incision through healthy tissue to do this is marked by a dotted line in the case of the male patient (Fig. 1).

The second stage (a complete tarsorrhaphy, covering a junction of lower bulbar conjunctiva and upper tarsal plate) is well shown in the second photograph of the male patient Fig. 2). Unfortunately, he was killed by a bus shortly after this photograph was taken, and the operation could not be completed.

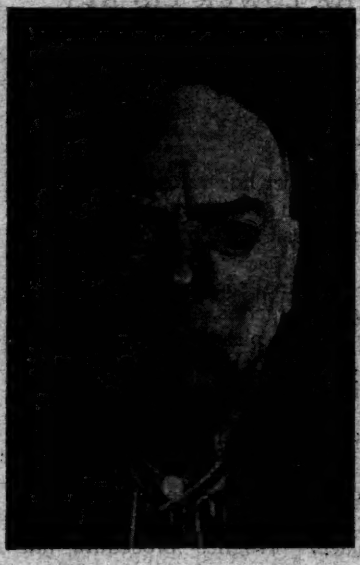

FIG. 1.

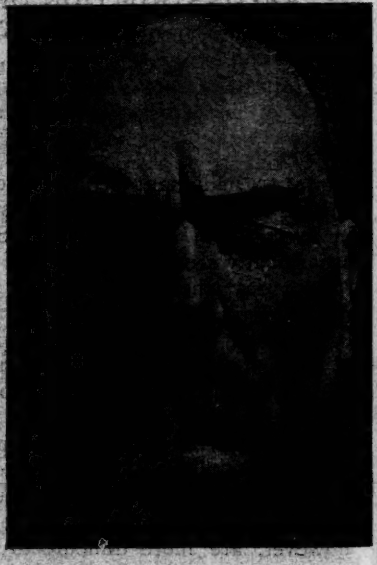

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

In the female patient (Fig. 3), I was able to graft a line of lashes into the lower lid, and to conclude the transfer of tarsal cartilage by opening the tarsorrhaphy (Figs. 4 and 5). This final stage of the operation is a little more difficult than one would suspect, owing to the difficulty of anaesthetising the inner surface of the tarsal

FIG. 8.

cartilage and conjunctiva. In future, I would always employ an intravenous anaesthetic.

Unfortunately, the eyebrow from which the graft was taken, is not a strong growth, and the new lashes are only visible on close inspection.

The vision is 6/6 in spite of a small area of punctate keratitis in the lower half of the cornea only visible with the slit-lamp.

The general cosmetic and functional result is satisfactory, however, as shown by Fig. 6, with the eye looking up, Fig. 7 with the lower lid retracted to show the depth of the fornix, and Fig. 8 with the eye closed.

CONGENITAL ECTROPION ASSOCIATED WITH BILATERAL PTOSIS—CASE REPORT*

BY

Lieut.-Col. STUART GORDON, R.C.A.M.C.

and

Major B. H. CRAGG, R.C.A.M.C.

A CASE of mild congenital ectropion of all four eyelids, associated with ptosis of the upper lids, is reported. We have not seen, nor have we found described in the literature, a similar condition, although our search of the relevant literature has not been exhaustive. The lesion would appear to be of sufficient rarity to justify this communication.

The patient, E. B., a male, aged 23 years, reported for treatment in December, 1942, because of the deformity of his eyelids and the discomfort resulting therefrom.

He slept with his eyes open, and, during the night, mucoid discharge accumulated in the palpebral fissures. Dust and dirt produced irritation which made it impossible for the patient to work where dust was present. There was mild epiphora.

His mother's eyes are reported to be normal. He has no personal recollection of his father but has been told that his father had a similar condition. There are six brothers and three sisters, of whom two brothers and one sister have defects of the same nature, although not so marked.

On examination the palpebral fissures are seen to slope slightly down and out. There is a mild degree of ectropion of all four lids in the outer half, more marked in the lower lids. Lashes are present in normal position and distribution. No evidence of bony abnormality of the face could be found on clinical or radiological examination. The upper lids were obviously short of skin, and could not be elevated actively.

Eye examination. (B. H. C.). In addition to these deformities this patient had an alternating hyperphoria and alternating convergent strabismus of about fifteen degrees. His vision was R. 6/12, L. 6/12, and a high degree of hypermetropic astigmatism existed. Vision could not be improved by the use of lenses. No fundal abnormalities were noted.

Treatment (S. G.) consisted in letting into each upper lid a thin Thiersch graft cut from the arm, and into the lower lids a Wolfe graft of post-auricular skin. This was followed some four months later by fascial slings hitching the upper lids to the frontalis muscle in order to overcome the ptosis.

* Received for publication, May 2, 1944.

The upper photograph shows the pre-operative appearance.
The lower photograph shows the post-operative appearance.

The patient is now able to elevate his upper eyelids easily. His ectropion is cured and he can protect his eyes from dust. During sleep his eyes are closed. The grafts in the lower lids are very satisfactory, in the upper lids they are still rather noticeable.

Summary

A case of congenital ectropion of all four lids, associated with ptosis of the upper lids, without any abnormality of the facial bones, whose condition has been improved by operative therapy, is reported.

ANGIOMA OF THE RETINA*

BY

Major I. C. MICHAELSON, R.A.M.C.

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DUKE-ELDER in his Text-book of Ophthalmology, Volume III, states that decision has not yet been reached regarding the relative merits of radium, radon seeds, roentgen therapy, electrolysis and diathermy in the treatment of angioma of the retina. This

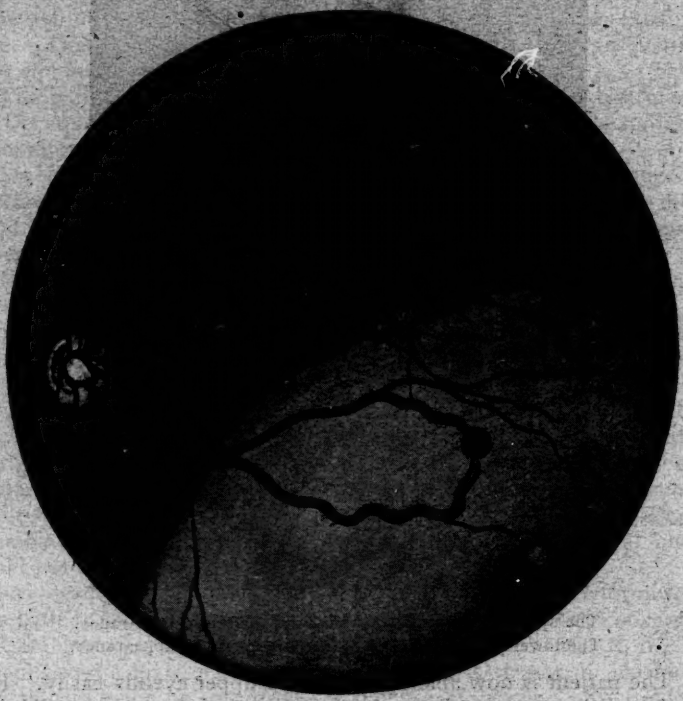

FIG. 1.

The appearance of the fundus on December 9, 1943. The detachment, tear, and angioma can be seen.

together with the infrequency of the condition would appear to merit publication of experience in the treatment of the following case.

* Received for publication, April 25, 1944.

Sgt. B. appeared for examination on December 9, 1943, with the complaint that suddenly the vision of the left eye had become defective two weeks previously. Prior to this his eyes had caused no trouble excepting the need to wear spectacles for short sight.

The visual acuities were as follows :—

Right eye with −5·50 D.sph. −1·25 D.cyl. 180° = 6/9.

Left eye with −6·50 D.sph. −0·50 D.cyl. 180° = 6/36.

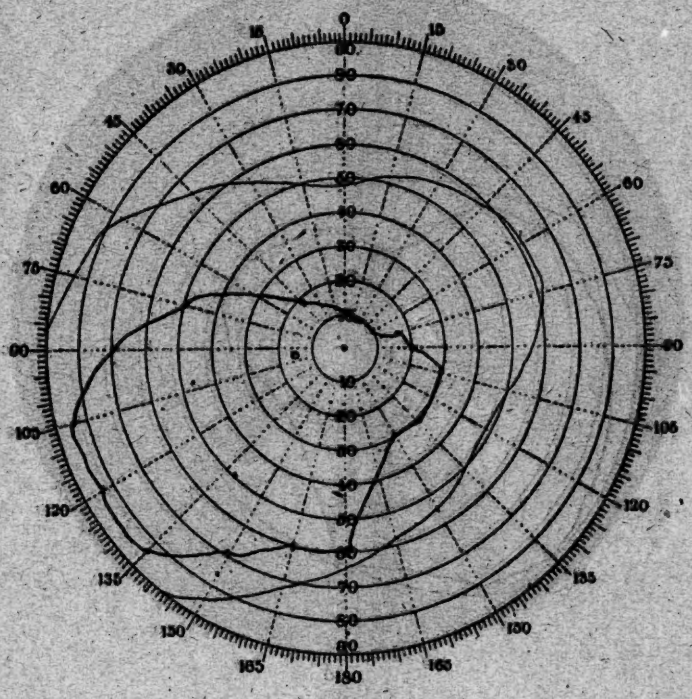

FIG. 2.

The visual field prior to operation.

The right fundus was normal excepting some tortuosity of a smaller branch of the inferior temporal vein.

The left fundus showed the following features :—

(1) A large retinal detachment chiefly in the lower temporal quadrant.

(2) A circular tear of the retina in the 4 o'clock meridian about 12 mm. from the disc. Through it the choroid could be seen to be atrophic.

(3) The inferior temporal artery and vein were very broad and tortuous specially where they lay in the detached portion of the retina and appeared to end in a circular raspberry-coloured angioma about 1/3 of the disc in diameter. In the detachment these two vessels had the same colouring.

Fig. 1 illustrates the fundal appearance. The vessels have been accurately reproduced but the fundal colouring is to some extent

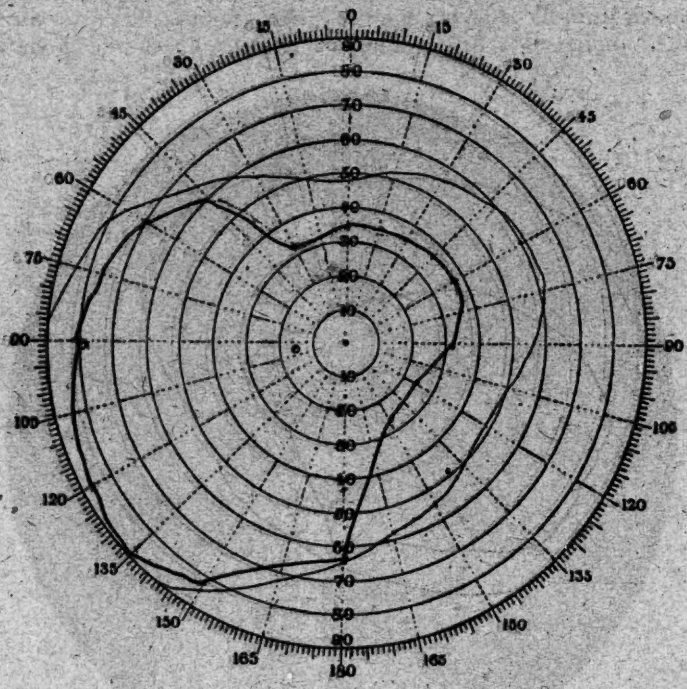

FIG. 3.

Enlargement of the field, especially nasally can be seen.

schematic. Fig. 2 shows the extent of contraction of the visual field of the left eye.

General medical examination was carried out by Major R. Mowbray, R.A.M.C., Medical Specialist. There was no clinical evidence in the central nervous system and elsewhere of any vascular or other abnormality. The family history was negative so far as it concerned disease of the eyes, nervous and vascular systems.

After the usual preliminary measurements for the localisation of the tear and the angioma had been done, operation under local anaesthesia was performed on December 30, 1943, as follows:—

(1) The localising measurements were confirmed by the production of electrolysis bubbles on the retinal surface at both the tumour and the tear.

FIG. 4.

The appearance of the fundus on March 22, 1944. The draining vein could not be definitely traced.

(2) Surface diathermy was applied over the site of the tumour. The 2 mm. ball was used for 14 seconds at two places.

(3) In similar fashion surface diathermy was applied over the site of the tear.

(4) Micropuncture was done into the tumour.

(5) Three micro-punctures were made in a vertical line up and in from the tumour with the intention of catching the feeding artery.

(6) Three micro-punctures were made in the region of the tear. From these about 15 minims of subretinal fluid were withdrawn by means of a sucker.

The Ophtherm diathermy apparatus was used.

The post operative progress of the case was uneventful. Both eyes were bandaged for 14 days. The patient was discharged to his Unit on February 21, 1944.

The condition when last seen on March 22, 1944, was as follows:—

Visual acuity of the left eye with −6·00 D.sph. −0·50 D.cyl. 180°=6/9 and Jaeger 1. Fig. 3 indicates the enlarged visual field. The fundal appearance is indicated in Fig. 4. The retina is in position. It can now be noted that the inferior temporal artery and vein cross each other although they did not appear to do so before the replacement of the retina. This effect was produced by the crossing taking place just where the vessels came forward to the detachment. The result of this observation was that the target during the operation was the draining vein instead of the feeding artery. It does not appear to have affected the result, however. The tumour appears to be occluded. The feeding artery is now of normal size and despite repeated searches the draining vein cannot be definitely traced.

Summary

(1) A description is given of a case of angioma retinae in which a tear as well as tumour was present.

(2) In this case the use of diathermy was efficacious.

I wish to acknowledge my indebtedness for permission to publish to Colonel J. Morrison, Officer Commanding, British General Hospital, and to Brigadier G. I. Scott, Consultant Ophthalmologist, Middle East Forces, who examined the case before operation and with whom the procedure was discussed.

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ANNOTATIONS

The Contracted Socket

So frequently has the result of reconstructive work for a contracted socket been disappointing that many eye surgeons have been discouraged from attempting the operation in severe cases. Grafts made to line the socket may be adequate at the time of operation but contract appreciably afterwards. The epithelial lining of the reconstructed socket becomes white, sodden, and often discharges copiously, and the socket may emanate an unpleasant smell. Sockets made by impressing a mould are deep and in such the prosthesis sinks back and has little or no mobility when the recti muscles are in action.

Some of these ill effects of grafting may be either removed or at least reduced by attention to certain technical details. Sockets are less foul when lined by a very thin dermo-epidermal graft such as may be cut by a carefully adjusted Humby's knife. The deep socket resulting in immobility of the prosthesis is avoided by preparing before operation a stent or glass mould which is oval and biconvex like a plus 16-20 lens, through which is bored one or two holes about 4 mm. in diameter. The long axis of the oval is placed transversely and the equator of this biconvex mould is made to reach within about 3 mm. of the orbital margins, that is the extent to which the soft tissues are separated in the floor of the socket. By removing this mould for cleansing purposes daily and replacing it for constant wear between dressings for 3 months contraction is to a large extent prevented. When the eyelids are in a reasonable state of preservation socket reconstruction is worth an attempt. In cases where the eyelids are much destroyed and the socket contracted it is generally preferable to abandon reconstructive work and after excising the conjunctiva to suture the skin edges together over the orbital cavity.

On Monocles

A paragraph in one of the Daily Pictorials last autumn drew attention to the fact that a Chief Petty Officer Electrical Engineer, R.N., who had worn a monocle in civil life before volunteering for the navy, decided to continue wearing it afloat. When questioned by his commanding officer he is stated to have convinced him that he had no reason for wearing "two windows" when one would do, and shortly after an Admiralty Fleet order headed Monocular Vision was promulgated.

The word monocle is one of those words of hybrid derivation, part

Greek and part Latin, which is as a red rag to a bull to the pedantic. But it is not of particularly recent development for we have met with a certain Simon Monoculus in a record of the time of King John. Simon was one of a crowd accused of murder but we never learnt what happened to him.

Most ophthalmic surgeons in the past have looked rather askance at the monocle and in the majority of instances with reason. For an uniocular person there can be no objection to the wearing of a monocle, but in the case of those with the statutory allowance of eyes it is usually unnecessary and we have even heard it hinted that the wearing of a monocle is a piece of affectation. For occasional use such as the scanning of a menu or programme a monocle is decidedly useful in presbyopes. And a person with one amblyopic eye may reasonably use a monocle if the seeing eye needs uncomplicated assistance such as a simple sphere. Such a man as Sam. Johnson, who had one very amblyopic eye, might have worn one, but we should have been sorry for the fellow members of his clubs who had to contemplate his appearance in it. If moderate or marked astigmatism be present it is usually best to advise against the wearing of a monocle, for it is difficult to ensure, even with a flanged frame, that the axis of the cylinder will be exactly in the right position.

ABSTRACTS

MISCELLANEOUS

(1) **MacCallan, A. F. (London).—Some diseases of the eye met with abroad.** *The Practitioner*, p. 71, February, 1944.

(1) The February number of *The Practitioner* contains a number of articles on diseases of the eye contributed by different authors by request. The present article is one of these; it mainly consists of an elementary exposition of the diagnosis and treatment of trachoma.

A. F. MACCALLAN.

(2) **Ray, Bronson S. and McLean, John M. (New York).—Combined intra-cranial and orbital operation for retinoblastoma.** *Arch. of Ophthal.*, Vol. XXX, No. 4, p. 437, October, 1943.

(2) **Ray** and **McLean**, analysing the literature, find that the average survival rate after enucleation for retinoblastoma is only 18 per cent., though in a recent report (1941) covering 31 cases, the rate has been improved to 35 per cent. The most important single

factor in the mobidity is extension of the growth backwards in the optic nerve and the degree of this cannot be estimated before operation. This is shown in a study of 119 cases by Reese, in 43 per cent. of which there was extension of tumour cells behind the cut end of the nerve, the size of the growth having no bearing on the degree of extension. Irradiation is helpful, and it has been shown in a series of six cases that if it is employed immediately after enucleation in cases where the tumour extends beyond the cut end of the nerve, there is a 66 per cent. chance of cure. The number of cases quoted is small, however, and even though irradiation improves the results, there seems justification for seeking a better method. This is supplied by an operation described in 1933 by Norman Dott and Spence Meighen, which has been further developed by the authors. The skull is opened by the "hypophysial approach" and the optic nerve on the affected side divided at its junction with the chiasma, and at the optic foramen. Twelve days later, the affected eye is enucleated. All six muscles are divided and an enucleation spoon is slipped round the back of the eyeball, so as to draw it forwards in one piece with a considerable length of the optic nerve and its sheaths. The authors describe two cases in which this operation was performed, and give details of technique.

F. A. W-N.

(3) **Sallmann, Ludwig von (New York).—Penicillin and sulfadiazine in the treatment of experimental intra-ocular infection with pneumococcus.** *Arch. of Ophthal.*, Vol. XXX, No. 4, p. 426, October, 1943.

(3) **Sallmann** reports an interesting investigation into the relative merits of sulphadiazine and penicillin in the treatment of pneumococcal infections of rabbit's eyes. A broth culture of organisms was used and by a special technique the approximate number of organisms injected was estimated. The results were as follows. Infection with B.pneumoniae type III and type X was not stopped, or was only temporarily improved by intensive local and general treatment with sulphadiazine, started six hours after inoculation. Severe infection with types III, X and VIII was usually checked by local treatment with the sodium or ammonium salt of penicillin in strengths of 0·25 and 0·1 per cent., even when this was delayed until twelve and thirteen hours after inoculation. Simultaneous injury of the lens capsule did not, in most cases, vitiate cure when the penicillin was started within eight hours. Iontophoretic introduction was occasionally more effective than the corneal bath when the infection was very severe, but was liable to produce a large corneal abrasion which, however, usually healed without opacity in a few days. In the six hour experiments, one treatment of five minutes was given on the first day, repeated on the morning of the

second day and supplemented by a three minute application in the afternoon. The applications were then reduced according to the progress of cure, the duration of treatment varying from two to six days.

F. A. W-N.

(4) **Roper, Kenneth L. and Bannon, Robert E. (Hanover, N.H.)—Diagnostic value of monocular occlusion.** *Arch. of Ophthal.*, Vol. XXXI (old series, Vol. LXXXVIII), No. 4, p. 316, April 1944.

(4) During the past two years **Roper** and **Bannon** have treated eighty patients by occlusion of one eye for symptoms which were thought to be due to anomalies of binocular vision. These anomalies comprise heterophoria, accommodation-convergence imbalance and aniseikonia. When relief from symptoms is brought about by monocular occlusion, one or more of these conditions may be inferred to be present, though failure of relief does not necessarily exclude them. The loss of binocular vision is in itself something of a trial, and for the test to be of value it should be kept up for at least two weeks. At the end of this time, the patient may report that though monocular vision is tiresome, it is less so than the headaches he experienced when both eyes were open. Various types of occluders can be used, the most satisfactory being an opaque contact lens, the front surface of which is made like a glass eye. Of the eighty patients, fifty-six were relieved by occlusion, and of these forty-seven were able to revert to binocular vision when aniseikonia and muscle anomalies revealed by the test were subsequently corrected. Of nineteen who were not relieved by occlusion, only five reacted favourably to treatment. Eleven patients gave indefinite results.

F. A. W-N.

(5) **Spaeth, M. D. (Philadelphia).—Traumatic liporrhagia retinalis (Verhoeff) Purtscher's disease.** *Arch. of Ophthal.*, Vol. XXXI, (old series, Vol. LXXXVIII), No. 3, March 1944, p. 191.

(5) This is a condition which may follow bone injuries, and **Spaeth** describes two cases following accidents involving crushing of the chest. The first patient died after a few hours, and showed tremendous engorgement and tortuosity of the retinal veins and arteries, with many massive haemorrhages. The second patient survived. He presented venous tortuosities and haemorrhages which were mainly venous. There was oedema round each macula which itself was occupied by a yellowish plaque, surrounded by a fringe of haemorrhages. There were other smaller white spots scattered about in the fundi, all in close proximity to the terminal vessels. Vision was little affected, being 6/12 in each eye with correction; 14 days later it had improved to 6/6 and the fundi were almost

normal, though later it went down to 6/9 and a tiny central scotoma was found. Many suggestions have been made as to the cause of the fundus changes. Thus the venous engorgement may be related to disturbance or thrombosis of the cranial sinuses, but this will not account for the yellow plaques and spots which are best explained as due to diffusion of fat droplets from the blood.

F. A. W-N.

(6) **Castellanos, Luis A. (Chihuahua, Mexico).—Ariboflavinosis as a probable cause of vernal conjunctivitis.** *Arch. of Ophthal.*, Vol. XXXI (old series, Vol. LXXXVIII), No. 3, March 1944, p. 214.

(6) Castellanos believes that spring catarrh is due to deficiency of riboflavin, brought about by destruction of the vitamin by the ultra-violet rays of sunshine, or by the demand for a greater quantity of it during the hot season. He claims to have proved this by the treatment of 105 patients with riboflavin, 92 of whom showed improvement. He advised, during the hot season of the year, drinking as much milk as possible, taking 1-3 mg. tablets of riboflavin per day, and the instillation of drops of tetracain hydrochloride and adrenalin. Thirty-five patients showed improvement of ocular symptoms on the third or fourth day, sixty-two in from ten to fifteen days, and the remaining nine did not return for examination.

F. A. W-N.

BOOK NOTICES

Education and Health of the Partially Seeing Child. By WINIFRED HATHAWAY. XIII + 216 pp., illustrated. Published for the National Society for the Prevention of Blindness, Inc., by Columbia University Press, New York, 1943. (Published in England by Messrs. Humphrey Milford. English Price 16/6).

This is an interesting and instructive book, unlike anything which the reviewer has read before, dealing with all aspects of the problem of the partially sighted child. It is arranged in four parts, under the headings historical background, administrative responsibilities, educational responsibilities, and community social service responsibilities. Reference is made in the first part to the start of the "myope school" in this country, and the evolution of similar institutions in America. The administrative side is fully dealt with, many aspects being considered, including classification, finding the partially seeing child, programme planning for town and country, school health services, supervision, finance, architecture and illumination, and equipment. On the actual teaching side, the "tool

subjects" (reading, writing, and arithmetic) are fully considered, and attention is given to child guidance, and the use of mechanical devices such as the talking book, typewriters, and the radio. Five appendixes deal with anatomy, physiology, and optics (for the lay person), subjective testing, lighting and equipment (with a useful list of the names and addresses of suppliers), and a glossary. There is a bibliography of some 40 references.

The authoress states in her foreword that the volume is intended for administrators, teachers, nurses, and social workers, and it should prove of great value to such of these as are concerned with child health and education. The ophthalmic surgeon, however, would be well advised to peruse it, both for the information it contains and for the insight it gives into the approach made to, and the progress made in, the subject in the United States.

NOTES

American Ophthalmological Society

THE 80th annual meeting of the American Ophthalmological Society was held at Hot Springs, Va., on May 29, 30, and 31, 1944. A number of important and interesting papers was read and the following officers were elected for the ensuing year. President, S. Judd Beach; Vice-President, Eugene M. Blake; Secretary-Treasurer, Walter S. Atkinson; Editor of Transactions, Wilfred E. Fry. The Council is composed of Louis S. Greene, Parker Heath, Lawrence T. Post, Everett L. Goar and Frederick C. Cordes. The Theses Committee has the names of John W. Burke, Algernon B. Reese and Georginna Dvorak-Theobold. Drs. Walter I. Lillie, S. Judd Beach and Walter S. Atkinson are Members of the Programme Committee.

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Ophthalmological Society of Egypt

THE Ophthalmic Gold Medal is of the value of L.E.20, and is awarded for the most valuable contribution brought before the Annual Congress each year. Further facts are given in Vol. XXVII, p. 522.

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Special Notice

WE are asked by the Ministry of Information to state that the fact that goods made of raw materials in short supply owing to war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export.